Space Weather Technical Forecast

Issued on Thursday, 17 August 2023 at 13:03 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: Initial Slight Chance of G1, falling into UTC weekend. Chance of R1/Minor Radio Blackouts throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity, as measured at GOES16, has been Low over the past 24 hours, with occasional mid-ranking C-class flares observed, peaking with a long-period CME-generating C3.6 recorded at 17/0245UTC from the southwestern limb. The region responsible may be Ex-AR3394, although this is now a few days over the limb, and it may instead be prominence-related.

There are currently up to nine sunspot regions on the disc at present. It is generally the case that the more complex or dynamic regions are near the solar meridian at present - with AR3409 perhaps showing the strongest growth but only peaking at a Cri/Beta by the period's end. Other groups of note were AR3403 to its immediate northeast, which saw gradual migration of some of its intermediate spots to its main penumbral leader and trailer to present as an Eki/Beta. AR3407 in the south-centre disc showed a slow spreading tendency but was a nominally slightly less potent Dsi/Beta. Perhaps the other notable mention is the large but open span of AR3405 in the northeast, which has been tentatively analysed as an Eao/Beta with a trailing Hsx group, but could alternatively be classed as a large but quiet Fso group.

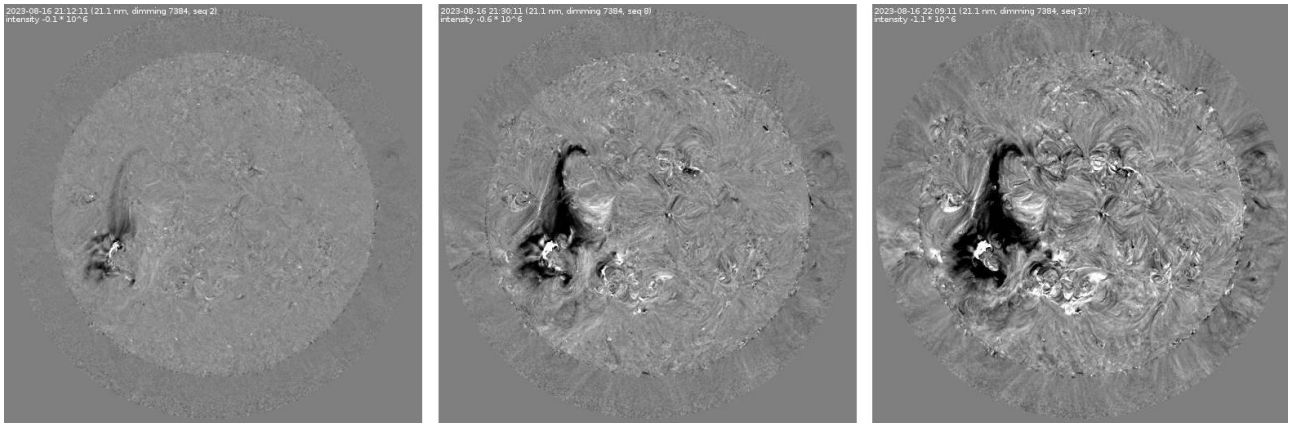

Figure 0: SIDC ROB-processed time-integrated AIA211 dimming surrounding a minor flare from AR3404 around 17/2123UTC. At the time of writing there is no clear link between this and any subsequent ejecta on coronagraphs, however the situation is being monitored.

Some of the more notable events in coronagraph imagery in the period include the CME following the peak flare mentioned above. This has been analysed, and although modelling result have yet to come back, any Earth-directed component is considered very unlikely. In many ways, the opposite problem occurred in a minor C2.0 flare from AR3404 at 17/2123UTC. There was a small filament channel subsequently visible in AIA304, but perhaps more concerningly an oversized AIA211 dimming that stretched well to the north and across the solar equator in subsequent

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imagery. There is not any clear ejecta on coronagraphs tied to this event at the time of writing, but it remains the main uncertainty and source of monitoring. At present then, no Earth-directed CMEs were observed in the available imagery.

Solar Wind / Geomagnetic Activity: The solar wind, as recorded by ACE at L1, was characterised by a discontinuity in many solar wind measures around 16/1300UTC. The solar wind speed and density changes were very muted, and the cause is not certain, but this could perhaps be a more decided entry in the overdue and evidently small magnitude CH33/+ given the more lasting phi angle change to positive (away from the Sun) in its wake.

The solar wind speed was subdued over the 24 hours, remaining within Background levels throughout, but with a hesitant very gradual upward trend from 300 to 340km/s or so. The solar wind density was highest in the possible CIR that preceded this 24-hour period, peaking immediately before 16/1300UTC at around 10ppcc before falling to more typical single figures (with note taken that ACE is the reporting satellite and under-reads relative to DSCOVR). The IMF became Slightly Elevated, rising to a peak 10nT before moderating later in the period. The north-south component was strongly anti-aligned with Earth's field at first, with a maximum deviation of -8nT, becoming smaller magnitude and more erratic into the current UTC day, with a co-aligned peak of +5nT.

The net result of the above solar wind measures was provisionally Unsettled at first, gradually falling with time to Quiet, with peaks of Kp '3-' observed.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux showed a lagged slight response to the peak X-ray flare of the period, peaking at around UTC dawn at fractions of a pfu. Higher energies in the spectrum were unmoved.

GOES16 high energy (greater than 2MeV) electron flux varied between Moderate and Normal Background levels with the diurnal cycle, peaking at 733pfu at 16/1550UTC. The associated 24-hour integrated fluence remained below Active (1e8 integrated pfu) on a slight decreasing trend reaching 1.18e7 integrated pfu at 17/0001UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is currently Low. There remains a daily Chance of Moderate activity, with the regions perhaps most likely to produce significant flares being AR3403 and AR3407 near the solar meridian.

Solar Wind / Geomagnetic Activity: There are no Earth-directed CMEs currently in the forecast.

Earth is likely now in a very weak fast wind, and should shortly experience a second similarly muted feature inside the next 24 hours. There is a peak Slight Chance of G1 at first that should fall to become largely Quiet once again over the coming UTC weekend.

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux is expected to remain at Background, with the most recent enhancement likely to have peaked and perhaps unlikely to repeat at higher level in the near-term.

High energy electron flux (greater than 2MeV) is anticipated to become suppressed upon the arrival of coronal hole fast winds at the start of the period. An increase is expected thereafter, possibly peaking at High levels. Corresponding electron fluence is therefore also likely to rise during the second half of the period, but now probably only slightly - probably comfortably below Active at peak.

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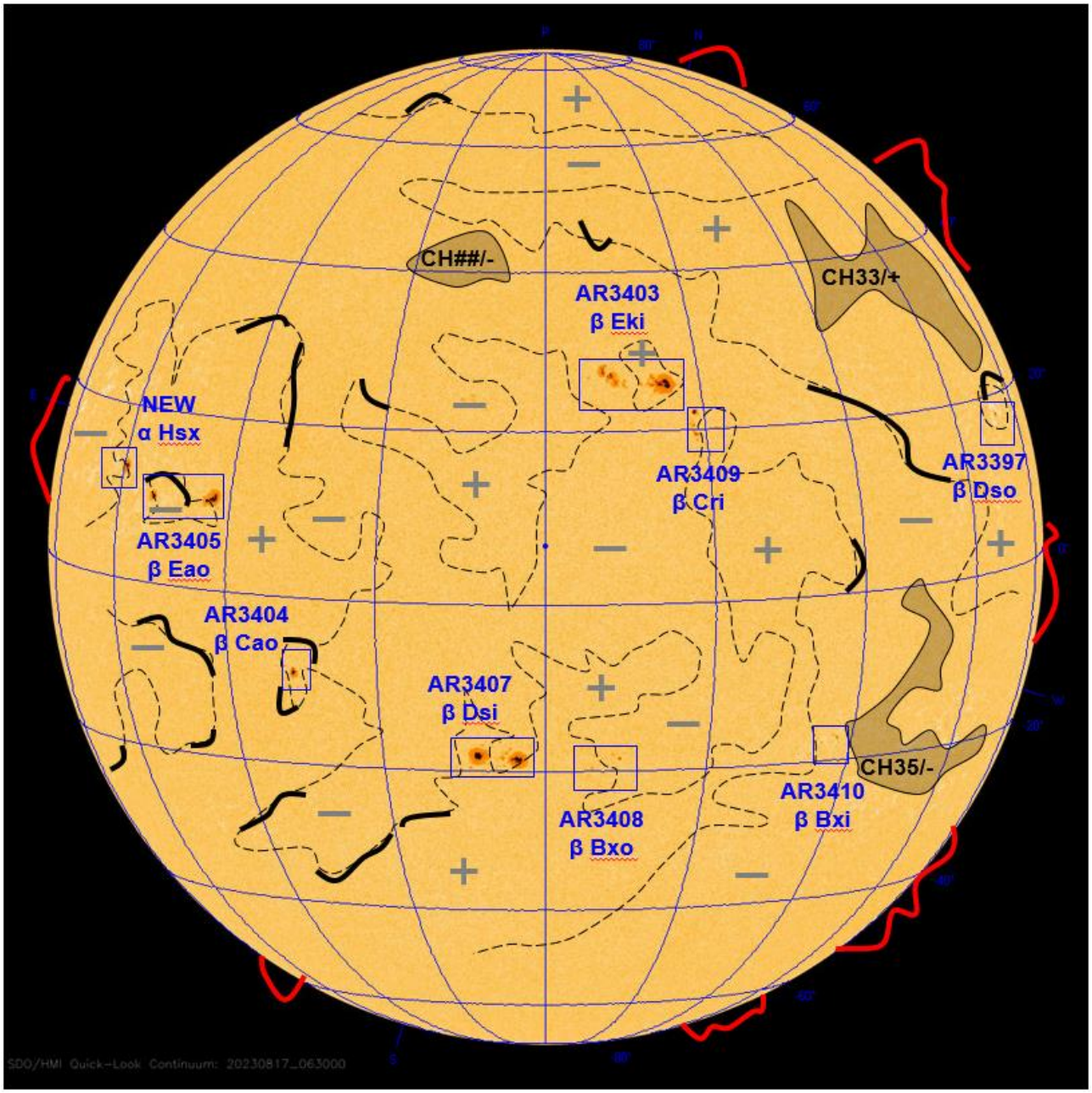
Figure 1. Solar Analysis Valid 17/0630UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no Earth-directed CMEs currently in the forecast.

On balance, Earth is now perhaps sampling the late and small magnitude fast wind of CH33/+, with peak geomagnetic activity only registering as Unsettled. The duration of this fast wind from CH33/+ at Earth is expected to remain relatively short, with CH35/- instead soon becoming geoeffective.

There are not yet any signals of a solar sector change 'upwind' at STEREO A from the current positive to negative (with STEREO A currently offering only a few hours' lead-time at best). CH35/- should arrive within the next 24 hours to provide the peak risk of G1 for the period, but only a Slight Chance, and fading should it occur beyond the current UTC day - for being manifestly slower and therefore weaker.

In addition to the above, there are the usual arguments regarding CH35/- being of the wrong polarity to generate a significant risk of G1/Minor Storm conditions. There are fewer aids to the forecast than usual at the current time, as MOSWOC Enlil currently shows an erroneous Elevated fast wind at present. Given its poor initialisation it is not considered to be giving good guidance, although this does too show a gradual fast wind exit through the period (perhaps by default).

Overall, with no CMEs and an imminent but minor fast wind due, the Slight Chance of G1 should fall away into the UTC weekend to leave a predominantly Quiet end to the forecast.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	1	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

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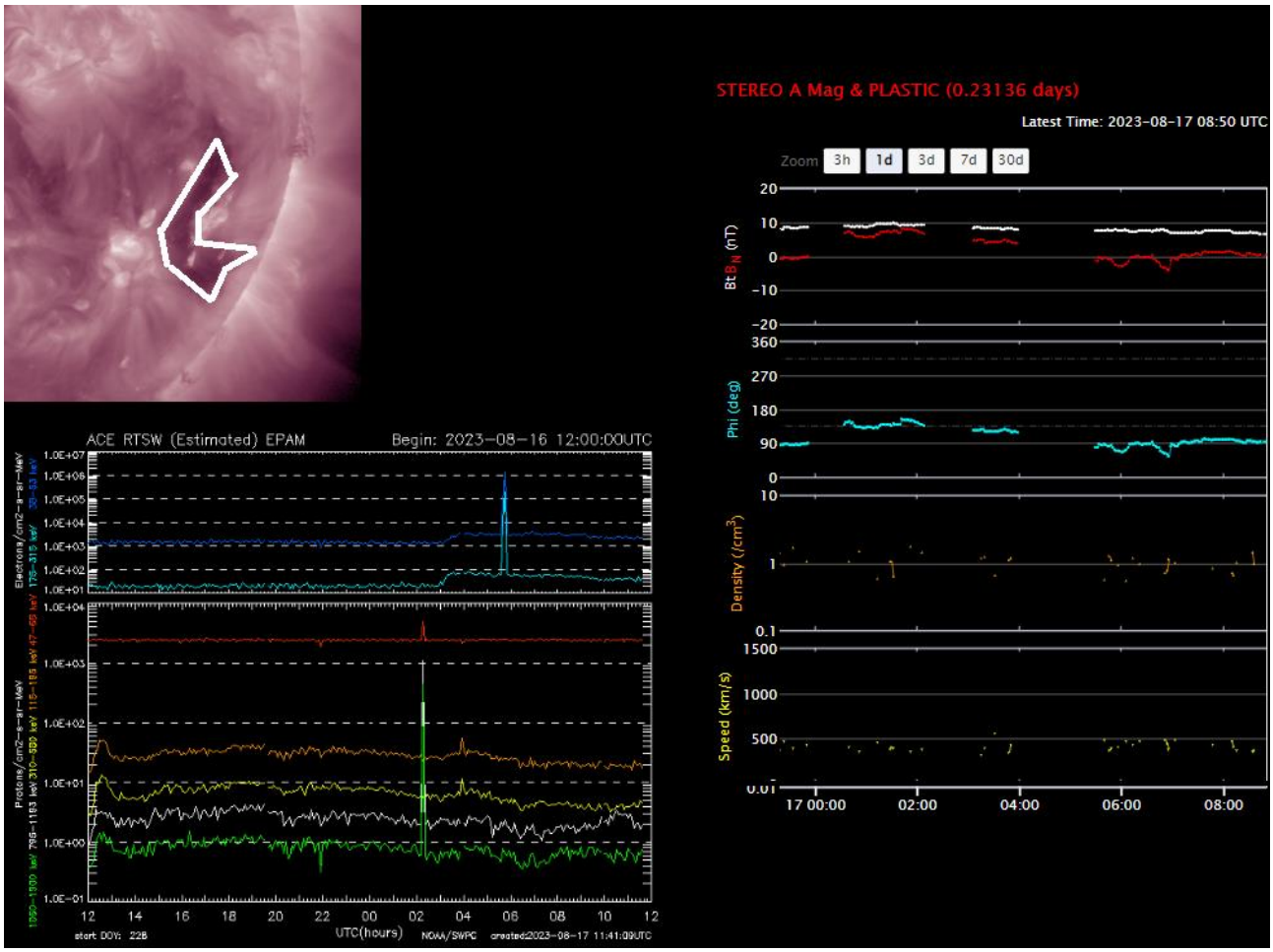
Figure 2: Clockwise from top left: AIA211 at 17/1000UTC, showing upcoming CH35/-; STEREO A MAG and PLASTIC, showing ongoing positive phi angle as at 17/0900UTC (with several hours' lead time); ACE EPAM LEMS, showing lack of any CIR-related slight uptick in the most recent measurements.



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Radio Blackouts - X-Ray Flares:

Solar activity is currently Low, however there is a daily Chance of Moderate activity, with the regions most likely to produce significant flares perhaps being AR3403 (Eki/Beta) and AR3407 (Dsi/Beta).

Regarding the balance of sunspot group numbers, AR3397 leaves the disc on day 2 (Friday 18 August), meanwhile there are signs from far sided products that a couple of regions may arrive over the eastern limb over the next couple of days to perhaps limit any fall in the daily chances of flares. Overall therefore, the flare risk is held constant, with a daily Chance of M-class activity.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	30	30	30	30
Very Active	R3 to R5 X Class	No	2	2	2	2

Figure 3: Past 24 hours' C-class flares and above, as recorded at PROBA2 and processed by SIDC ROB. Most recent activity can be seen to be from the departing western limb, rather than the nominally complex regions near the solar meridian – part of the rationale for a slightly suppressed daily Chance of M-class flares relative to suggested raw values from their Zurich classes' histories.

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Solar Radiation Storms - (High Energy Protons):

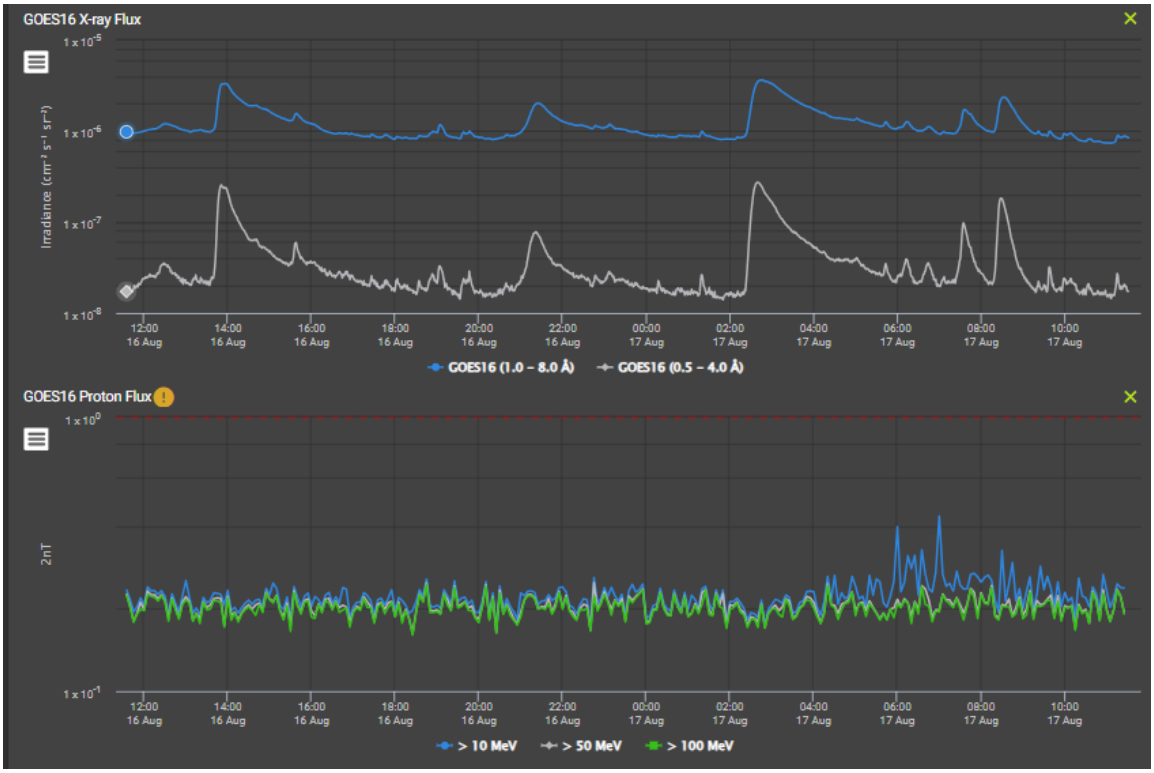
The flux of high energy protons (greater than 10 MeV) has shown a very slight uptick in response to the C3.6 flare from the southwestern limb in recent hours. This enhancement was confined to 10MeV protons only, and appears to have already plataeued. Given its small magnitude, this event does not impact on the forecast probabilities for day one or beyond, as any region responsible lies near its most potent location and the threat should progressively reduce into the coming weekend.

Solar radiation levels should remain near this level through the period, with a continuing very slight chance of an S1 event as the larger and more complex regions on the visible disc move into the western hemisphere over the coming days.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	5	5
Very Active	**≥ S3 ***	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 4: Past 24 hours in GOES16 X-ray flux (top) and resulting high energy proton flux (bottom). A delayed and damped response to the peak flare of the 24 hours was regstered, but given the fact that this emanated from the best-connecting part of the Sun (with Earth) and still produced such a small response improves confidence that S1 remains unlikely.



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High Energy Electrons Event (≥ 2MeV):

The diurnal flux oscillation has been attenuated since around midweek by a slight increase in geomagnetic activity, with flux now only peaking at Moderate. This is likely to be further suppressed at GEO by any imminent fast wind from CH35.

The chances of Active 24-hour integrated fluence are very low at first, with an uncertain rise and recovery expected over the coming UTC weekend. The magnitude of this is now perhaps lower than previously advertised as a result of the very subdued fast wind from CH33/+. With CH35/- not expected to be particularly marked either, and with no complicating CMEs in the forecast, the fluence may rise but this will probably be comfortably below the Active threshold by the time it saturates into the new UTC week.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^{8}$**	No	1	10	20	20
Very Active	**≥ 2 MeV ≥ $1x10^{9}$**	No	1	1	1	1

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